

### **REMARKS**

Claims 1, 2, 5-11, 14, 15, and 22-27 are in the application. Reconsideration and withdrawal of the rejections is requested in view of the following remarks.

By this Amendment, new claim 27 has been added. New claim 27 is supported at 0039. An RCE is filed with this Amendment.

The claims describe methods where a liquid layer or liquid boundary layer is formed on the workpiece. The liquid layer may be formed by applying liquid onto the workpiece, or via use of steam. The thickness of the liquid layer is controlled. Ozone gas reacts to clean or process the workpiece. The ozone gas may diffuse into and through the liquid layer, dissolve into the liquid, or be entrained in the liquid, or a combination of them may be used.

Turning to the prior art, Lampert *et al.*, U.S. Patent No. 5,131,983, describes a process using a process gas (which may be ozone, among various others) in a mist of water. Lampert *et al.* does not suggest use of a liquid layer as claimed. In view of paragraph 7 of the 05/04/06 final office action, applicant has carefully reviewed Lampert *et al.* with respect to the claimed liquid layer. Each passage in Lampert *et al.* which could ever arguably relate to use of a liquid layer is reproduced below, including potentially ambiguous passages. Underlining is added for emphasis of certain phrases. Review of these suggestions demonstrates that Lampert *et al.* does not disclose, expressly or inherently, use of a liquid layer.

Abstract:

A process for the wet-chemical surface treatment of semiconductor wafers in which aqueous phases containing one or more chemically active substances in solution act on the wafer surfaces, consisting of spraying a water mist over the wafer surfaces and then introducing chemically active substances in the gaseous state so that these gaseous substances combine with the water mist so that there is an interaction of the gas phase and the liquid phase taking place on the surface of the semiconductor wafer.

Col. 2, lines 1-9:

Accordingly, the present invention provides a process wherein chemically active substances are introduced in the gaseous state, and water is provided in a finely divided liquid state such as a mist, into a system containing the semiconductor wafers to be treated, and the phases acting on the semiconductor surfaces in the system are generated by the interaction of the chemically active gases and the liquid phase or water mist.

Col. 3, lines 40-50:

The water is introduced into the system containing the wafers to be cleaned in the form of a mist. The water can, for example, be sprayed in, fed in through nozzles or aerosolized. Nozzle systems used in conventional spray etching or spray cleaning processes are suitable for applying agents to the semiconductor wafers to be treated. Advantageously, droplet size, jet direction and jet force are matched to

each other so that, at least in the region in which the semiconductor wafers are provided, a uniform aerosol-like water mist is built up.

Col. 3, lines 52-55:

Suitable gaseously supplied chemically active substances are those which can interact with the finely divided water to form phases which are active on the wafer surface.

Col. 3, lines 64-67:

It is then possible to control the supply of finely divided water and gaseous, chemically active substances and their uniform action on the wafer surfaces. The liquids produced in the process can also be collected and removed.

Col. 4, lines 12-17:

In principle, it is also possible to operate mixed systems which have both the facility for introducing gases and also solutions. For example, a mixed system can be used where certain mixtures are employed which cannot be produced, or can only be produced with difficulty, in a gaseous phase, such as, for example, hydrogen peroxide/ammonia or hydrogen peroxide/hydrogen chloride solutions.

Col. 4, lines 18-23:

Advantageously, the aqueous phases produced are removed as quickly as possible from the system after they have acted on the wafer surface in order not to

upset the balance established between the solid, liquid and gas phases, and to aid in the removal of contaminants which have been collected in the process.

Col. 4, lines 34-47:

As a guide line, use may be made of the concentration values which are determined from conventional liquid-only processes for the corresponding solutions. From these concentrations, the quantitative ratios, and the required flow rates for components of the system can be derived, in each case, to a first approximation. For example, in the case where about 10% by weight hydrochloric acid solution is used, the quantities of hydrogen chloride gas and of finely divided water supplied to the system per unit time can be adjusted to a ratio by weight of about 1:9.

Col. 4, lines 58-66:

A converted spray etching chamber can, for example be used in which a continuous water mist is produced by means of a plurality of nozzles. Hydrogen fluoride gas is then injected into the system for a short time, and hydrofluoric acid is formed. This strips any oxide layer formed, together with the contaminants contained therein from the wafer surface. After the HF gas is stopped, and while continuing to spray in water, the wafers are washed until acid-free. Then an ozonized oxygen stream is introduced for a short time to cause the formation of a superficial oxide layer. The wafers are then washed in the additive-free water mist.

Col. 5, lines 58-60:

Furthermore, it was possible to spray water into the chamber using a nozzle system that provided a homogeneous, aerosol-like spray mist in the interior space.

Col. 6, lines 6-11:

A process tray loaded with approx. 25 polished silicon wafers (diameter approx. 10 cm) was then placed on the rotating dish located in the system and rotated along the longitudinal axis of the spray chamber. At the same time, water was sprayed in and the wafers were quickly surrounded by a dense water mist.

These sections, which are the only sections in Lampert *et al.* relevant here, show that Lampert *et al.* uses only a mist of water, and not a layer of liquid, as claimed. While the Examiner is correct that Lampert *et al.* refers to a "wet process," the Lampert *et al.* process is "wet" only in the sense that it uses a mist of water. Nothing in Lampert *et al.* suggests that the mist condenses or otherwise forms a layer of liquid, as claimed. Moreover, even if mist in Lampert condenses on the wafer, and the condensed mist is considered to be a vapor, there is nothing in Lampert *et al.* to further suggest the claimed step of then controlling the thickness of the presumed layer of liquid.

Lampert also contemplates a batch process, Col. 6, lines 6-9, and not a single wafer process, as claimed. A batch process is clearly consistent with a mist/vapor process, since the mist fills the chamber to contact the wafers. In contrast, the claimed process is a single wafer process, not a batch process. In the claimed process, a layer of liquid is formed on a single wafer. This process is not consistent

with a batch system, such as Lampert, since trying to reliably provide a uniform liquid layer on wafers spaced slightly apart from each in a rotor (as suggested in Lampert at Co. 6, lines 8-9) would be problematic.

Lampert *et al.* also does not suggest diffusion of ozone, or any other process gas, through a liquid layer, as described in claim 1. Rather, in Lampert *et al.*, the process gas reacts with water mist, with the gas/mist then acting on the wafer surface. Diffusion is not mentioned or suggested. Indeed, Lampert *et al.* makes no mention of, and provides no motivation for, having a liquid layer, and then having a process gas diffuse through the liquid layer.

EP 782 177 is cited at page 3 of the 05/04/2006 final office action as disclosing controlling the thickness of a liquid layer. Careful review of EP 782 177 shows that this reference discloses conducting a stream of water onto a spinning wafer during a rinsing step. Page 2, line 56 and page 3, line 22 and lines 49-55.) EP 782 177 describes that rinse time, spin rate and/or water flow rate may be adjusted (page 3, lines 56-58). However, there is no discussion of controlling a thickness of a layer of liquid on the wafer, as claimed. In EP 782 177, rinse water is provided from a side outlet 11, presumably as a single stream, directed towards the center of the wafer, as shown in Fig. 1. The stream in EP 782 177 suggests that controlling the thickness of the liquid layer is not important. In EP 782 177, spinning is performed to create a flow for rinsing, without regard to controlling a liquid layer thickness as claimed. The following sections of EP 782 177 discuss the spinning step:

"The etched wafer is spun and rinsed by conducting a stream of deionized liquid water onto the spinning wafer...." Page 2, lines 55-59.

"The present invention includes an anhydrous HF gas and water vapor etch process, the etching process being completed by a rinsing step which includes conducting a stream of deionized liquid water onto a spinning wafer with anhydrous HF gas, HCL gas, ozone, or mixtures thereof being present...." Page 3, lines 22-26.

"The rinse step may be controlled to meet the desired results by adjusting the rinse time, the spin rate, and/or the water flow rate." Page 3, lines 56-57.

Accordingly, in EP 782 177, the spinning is performed to control the rinse step, without regard to the thickness of a liquid layer on the wafer, as claimed. Consequently, EP 782 177, does not disclose controlling a thickness of a liquid layer. Moreover, even if EP 782 177 did disclose controlling the thickness of a liquid layer, since Lampert *et al.* does not reasonably disclose use of any liquid layer, there would be no motivation to combine any controlling step from EP 782 177 with Lampert *et al.* And, even if EP 7822 177 could be viewed as disclosing both use of a liquid layer (during actual processing – and not just in rinsing) and controlling the thickness of the liquid layer, combining these two steps with Lampert *et al.* would directly conflict with the repeated statements in Lampert *et al.* to use a mist – and

not a layer of liquid. For these reasons, the claims are not obvious over Lampert *et al.* and EP 782 177. In view of the foregoing, the claims are patentable over the prior art. A Notice of Allowance is requested.

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